Public Document No. 147

The Commonwealth of Massachusetts

ANNUAL REPORT

OF THE

METROPOLITAN DISTRICT WATER SUPPLY COMMISSION

FOR THE

YEAR ENDING NOVEMBER 30, 1932

PUBLICATION OF THIS DOCUMENT APPROVED BY THE COMMISSION ON ADMINISTRATION AND FINANCE

900-4-'33. No. 7962

REPORT OF THE METROPOLITAN DISTRICT WATER SUPPLY COMMISSION

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan District Water Supply Commission, established under the provisions of Chapter 375 of the Acts of the year 1926, respectfully presents for the year ending November 30, 1932, its

SEVENTH ANNUAL REPORT

I. Organization and Administration

Davis B. Keniston continued during the year as Chairman of the Commission, and Charles M. Davenport and Thomas D. Lavelle, both of Boston, as Associate Commissioners. R. Nelson Molt continued as Secretary.

The clerical force of the Commission's office at Boston remained the same throughout the year, and three special agents under the direction of the Commission, continued to care for property acquired by the Commission in the Swift River and Ware River areas. Real estate purchasing agents and conveyancers and other experts were employed as needed. The engineering and clerical force of the engineering department averaged 131 employees during the year. The maximum number employed at any one time by contractors on the various construction projects during the year was 541 persons.

II. Engineering Department

Frank E. Winsor continued as Chief Engineer, Karl R. Kennison as Designing Engineer, and Walton H. Sears as Mechanical Engineer.

The field divisions were continued in charge of three division engineers as follows: Wachusett-Coldbrook Tunnel Division, William W. Peabody; Coldbrook-Swift Tunnel Division, Richard R. Bradbury; Swift River Reservoir Division, N. LeRoy Hammond.

The Commission retained the services of J. Waldo Smith, formerly Chief Engineer of the New York Board of Water Supply, and the services of X. H. Goodnough, Inc., as consulting engineers. Charles T. Main of Boston was employed from time to time as a general consultant on mill and water power damages and also on the design of the dam and dike of Quabbin Reservoir. Dr. Charles P. Berkey of Columbia University continued as consulting geologist. Other consultants were employed from time to time as needed.

III. Offices

The office of the Commission and of the Chief Engineer continued on the ninth floor of the Metropolitan District Commission Building at 20 Somerset Street, Boston. The division offices for the Quabbin Aqueduct, heretofore referred to as the Wachusett-Coldbrook Tunnel and the Coldbrook-Swift Tunnel, and the Quabbin Reservoir, heretofore referred to as the Swift River Reservoir, were continued at Holden, Hardwick and Enfield respectively. The laboratories for water analysis and soil testing were continued at Enfield.

IV. Real Estate

The Commission, for reservoir purposes, has concluded the purchase of (or has under option) a total of 49,756 acres of land in the Swift River watershed, and for sanitary protection and construction purposes in the Ware River watershed a total of 4,067 acres.

The Commission acquired by eminent domain 226.06 acres of land in the towns of Ware and Enfield and Greenwich for construction purposes for the main dam and dike of Quabbin Reservoir in the Swift River valley.

The Commission, acting under the provisions of Section 4 of Chapter 321 of the Acts of 1927, has negotiated settlement with the Thorndike Company of Boston, Massachusetts, of all damages for the present and future diversions of the waters of the Ware and Swift Rivers.

The Commission continued, through duly appointed agents, the direction of the town government of the Town of Prescott as provided by Chapter 340 of the Acts of 1928. A financial statement for the town is included in the Commission's report to the Commissioner of Corporations and Taxation.

V. Reservoirs and Aqueducts

The Commission on October 25 gave the name Quabbin Reservoir to the reservoir to be constructed in the Swift River valley and previously referred to as the Swift River Reservoir.

The Commission also gave the name Quabbin Aqueduct to the tunnel which will connect Quabbin Reservoir and Wachusett Reservoir, consisting of the Wachusett-Coldbrook Tunnel already constructed and in operation for diverting the flood flows of the Ware River at Coldbrook into Wachusett Reservoir, and its extension, the Coldbrook-Swift Tunnel, now under construction from Coldbrook to Greenwich.

VI. Cemeteries

The Commission on May 18 gave the name Quabbin Park Cemetery to the new cemetery established by the Commission in the Town of Ware at the easterly end of the relocated portion of the state highway between Ware and Belchertown. On August 25 the Commission notified and requested officials in charge of the following cemeteries that no further interments should be permitted in these cemeteries, replaced by the new Quabbin Park Cemetery:

Town	*Cemetery*
Belchertown	Blue Meadow
Dana	Pine Grove, Towne
Enfield	Woodlawn, Church, Cemetery Hill
Greenwich	Greenwich
Prescott	Fish Hill, Pelham Hollow, Pine Grove, Town House, Jason Powers
Shutesbury	Hamilton

Parties interested in the removal of bodies were given the privilege of selecting lots in Quabbin Park Cemetery. The Commission has provided for the sale of lots in Quabbin Park Cemetery to any person who may have had an interest in the cemeteries from which bodies are to be removed.

The Commission has constructed a receiving tomb at the entrance of Quabbin Park Cemetery and the cemetery site has been cleared and landscaped and driveways completed throughout.

In consequence of requests from relatives of deceased persons, 233 bodies have been removed from the Quabbin Reservoir area during the year and of this number 62 have been interred in Quabbin Park Cemetery since August 25, when lots in this cemetery were first available. A total of 760 bodies have been removed from the Quabbin Reservoir area.

VII. Ware River Supply

The Commission, in accordance with the provisions of Chapter 375 of the Acts of 1926, during the period between December 23, 1931, and October 22, 1932, diverted down Shaft 8 through the Quabbin Aqueduct, previously referred to as the Wachusett-Coldbrook tunnel, into Wachusett Reservoir, 9,735,200,000 gallons of water.

Work was completed by Munroe & Westcott, Inc., under two contracts, numbered 24 and 25, for the construction respectively of the superstructure of the intake building for the Ware River intake works at Shaft 8, and of the superstructure of the outlet works at Shaft 1, and by Anderson-Coffey Company, Inc., under contract No. 26 for electrical work in the latter building.

Two contracts, numbered 28 and 29, awarded to Anthony Ross & Son, in August, 1931, for grading the grounds, respectively, of the Ware River intake building in the Town of Barre, and of the Wachusett outlet building in the Town of West Boylston were completed.

Contract No. 31, awarded in August, 1931, to E. D. Ward Company, for constructing the superstructure of the head house at Shaft 4 of the Quabbin Aqueduct in the Town of Rutland, was completed.

VIII. Swift River Supply

Real estate and topographic surveys were continued during the year.

The Wenzel & Henoch Construction Company, who in April, 1931, was awarded a contract, numbered 20, for the 10.4 miles of Quabbin Aqueduct to be constructed in the towns of Barre, Hardwick and Greenwich between the Ware River intake works at Coldbrook and Quabbin Reservoir, continued their work. About 70% of the rock excavation to be removed under this contract has been completed.

Contract No. 21, awarded in July, 1931, to The Lane Construction Corporation, for the construction of a substitute highway in the Towns of Ware and Belchertown, was completed and the highway was turned over to the Department of Public Works on September 7 and on September 22 opened to traffic as a state highway. This highway, about 5.26 miles in length, is a substitute for that portion of the Ware-Belchertown road passing through the Quabbin Reservoir area in the towns of Ware, Enfield and Belchertown and is a portion of state highway designated 109.

Contract No. 30, awarded in July, 1931, to the Northern States Contracting Company, for constructing the stream control works preliminary to the building of the main dam of Quabbin Reservoir in the Swift River valley, was nearly completed.

Contract No. 32, awarded in September, 1931, to The Dravo Contracting Company, for constructing exploratory caissons at the proposed sites of the main dam and dike of the Quabbin Reservoir in the Town of Enfield and in the Town of Ware, to disclose the character of subsurface material and conditions for the determination of the type and design of those structures, has been completed.

Contract No. 34, awarded in October, 1931, to The Lane Construction Corporation, for the construction of an entrance and driveways in Quabbin Park Cemetery in the Town of Ware, has been completed.

The Commission on November 8 authorized the advertisement for sealed proposals to be publicly opened and read on December 9, 1932, for constructing a core wall to sound rock at the site of the proposed dike of Quabbin Reservoir on Beaver Brook in the towns of Enfield and Ware.

IX. Watershed Protection

The Commission has purchased some additional properties for protection of the water taken from the Ware River, and in conjunction with the Department of Public Health has continued its studies of possible sources of pollution and the best methods of its elimination. The operation of temporary chlorinating plants installed at two points in the upper watershed of the Ware River to disinfect the effluent from the temporary State Prison Camp and the Rutland State Sanatorium and private hospitals in the Town of Rutland were continued as required.

The Commission, under the provisions of Chapter 262 of the Acts of 1932 authorizing the construction and maintenance of a sewerage system, or systems, for the purpose of maintaining and protecting the purity of the water supplies from the Ware River and Wachusett watersheds, has caused investigation to be made relative to the location of a sewer line and the disposal of sewage.

X. Financial

The Commission appends hereto a statement of its expenditures and disbursements for the fiscal year, and from the date of its appointment.

XI. Other Reports

The report of the Chief Engineer is herewith presented.

Respectfully submitted,

DAVIS B. KENISTON, *Chairman.*
CHARLES M. DAVENPORT, *Associate Commissioner.*
THOMAS D. LAVELLE, *Associate Commissioner.*

20 Somerset Street, Boston, Massachusetts,
January 14, 1933.

REPORT OF THE CHIEF ENGINEER

To the Metropolitan District Water Supply Commission.

GENTLEMEN: — The following is a report of the engineering department for the year ending November 30, 1932.

ORGANIZATION

In numbers the engineering organization has not materially changed during the year.

Karl R. Kennison, Designing Engineer, continued in charge of all studies in connection with the general plan of the work and the design of structures, preparation of contract specifications, contract and working drawings. He also continued as principal assistant to the Chief Engineer.

Charles L. Coburn and Stanley M. Dore, Assistant Designing Engineers, continued their general supervision of the detailed work of the office; and Walton H. Sears, Mechanical Engineer, continued in charge of the collection of data in connection with mill and water power damages. They have assisted in the preparation of contract specifications.

Three division engineers continued in charge of field divisions as follows: William W. Peabody, Wachusett-Coldbrook Tunnel Division; Richard R. Bradbury, Coldbrook-Swift Tunnel Division; N. LeRoy Hammond, Quabbin Reservoir Division, designated until October 25, as the Swift River Reservoir Division.

X. Henry Goodnough, Inc., and J. Waldo Smith continued as consulting engineers. Charles T. Main, consulting engineer of Boston, Dr. Charles P. Berkey, geologist of Columbia University, Arthur A. Shurcliff, landscape architect of Boston, and other experts were employed from time to time.

The employees under the direction of the Chief Engineer at the end of the year and the preceding year were as follows:

	Nov. 30, 1931	Nov. 30, 1932
Headquarters Office, Designing Division	33	36
Holden Office, Wachusett-Coldbrook Tunnel Division	23	22
Hardwick Office, Coldbrook-Swift Tunnel Division	28	30
Enfield Office, Quabbin Reservoir Division	39	47
Total Engineering Force	123	135

The maximum force during the year was 135, during the eight weeks ending August 27, and the six weeks ending November 26. The minimum force was 125, during the two weeks ending December 12, 1931. The average force for the year was 131.

OFFICES

The office of the Chief Engineer and Designing Division was continued in the Metropolitan District Commission Building at 20 Somerset Street, Boston. The field office of the Wachusett-Coldbrook Tunnel Division was continued at Washburn Hall, Holden Center. The field office of the Coldbrook-Swift Tunnel Division was continued in the brick building formerly used as a school at Hardwick Center. The field office of the Quabbin Reservoir Division was continued in the property of the Commonwealth formerly known as the Frances W. Chandler house on Quabbin Road, and the laboratories for water analysis and for soil testing were continued in the property of the Commonwealth formerly known as the Barlow house, in Enfield.

HEADQUARTERS OFFICE

Summary of the Year's Work

Real Estate. — Reports and recommendations with respect to the purchase of real estate in the Quabbin Reservoir area were submitted to the Commission during the year covering 3,614 acres, making a total to date of 66,723 acres.

PROGRESS OF REAL ESTATE NEGOTIATIONS FOR QUABBIN RESERVOIR

	Total Area Negotiated Including Owners' Offers to Sell to Commonwealth (Acres)	Area not Required (Acres)	Title Vested in Commonwealth (Acres)
Total for Year ending Nov. 30, 1932	3,614	458	3,762*
Total to Nov. 30, 1931	63,109x	6,887x	44,980x
Total to Nov. 30, 1932	66,723	7,345	48,742

Options outstanding Nov. 30, 1932, include 1,014 acres.

Acreage is based partly upon surveys and partly upon information obtained from deeds. x Corrections of the acreage are made from time to time as information is available. See appended table.

*Includes some offered in previous years.

Reports and recommendations were submitted to the Commission with respect to the purchase of real estate for sanitary protection in the Ware River watershed above the intake works at Coldbrook.

PROGRESS OF REAL ESTATE PURCHASES FOR WARE RIVER WATERSHED PROTECTION

	Title Vested in Commonwealth (Acres)
Total for year ending Nov. 30, 1932	1,273
Total to Nov. 30, 1931	2,794
Total to Nov. 30, 1932	4,067

Contracts and Specifications. — Working drawings for Contracts 20, 30 and 32 were prepared and issued.

Contract 35 was prepared, for the purchase of electricity at the site of the main dam in Enfield in order that experiments might be made on lowering of the ground water level by pumping from the experimental caisson sunk under Contract 32. The contract was executed June 2.

Contract 37 was prepared, for the purchase of electricity at the site of the dike in Enfield in order that the lowering of the ground water level effectively begun under Contract 32 might be continued. The contract was executed September 21.

Plans and specifications were prepared for Contract 36 for constructing a core wall to sound rock at the site of the dike of Quabbin Reservoir in the towns of Enfield and Ware, by sinking a row of concrete caissons across the bottom of the valley and sealing them to the ledge and to each other. The contract was advertised November 10, for the opening of bids on December 9, 1932.

Inspection and Tests. — E. L. Conwell and Company continued the testing of cement. The Worcester Polytechnic Laboratory continued the testing of concrete cylinders and steel reinforcement bars. The inspection of structural steel work and iron castings furnished under Contract 30 was made by our own engineering force.

Hydrographic Data. — The gaging station on the Ware River at Coldbrook was continued in cooperation with the United States Geological Survey. A recording gage was installed in the Ware River intake works to provide a continuous record of the pond level upstream from the main spillway and to supplement during flood flows the record obtained from the submerged weir station below the dam.

The gaging station on the Chicopee River at the United Electric Light Company plant at Bircham Bend was continued in cooperation with that company and the United States Geological Survey, and further discharge measurements were made from time to time to define the rating curve more exactly.

The gaging station on the Chicopee River at the Red Bridge plant of the Ludlow Manufacturing Associates was continued in cooperation with that company and further discharge measurements were made from time to time to define the rating curve more exactly.

The gaging station on the Swift River at the plant of the Boston Duck Mills of the Otis Company at Bondsville was continued in cooperation with that company.

Cooperation with the United States Geological Survey in the operation and maintenance of the gaging station on the Connecticut River at Thompsonville, Connecticut, was continued.

In connection with the examination of the waters of the Ware, Swift and Chicopee rivers, observations of flow were continued from time to time and additional temporary gaging stations established as required.

Ware River Diversion

The diversion of Ware River water into Wachusett Reservoir was continued. With minor exceptions, the flow in the river was not sufficient on any day from December 1 to 22, inclusive, 1931, to permit diversion. The first diversion of the year was made December 23, 1931, and the works were operated during the winter and spring months through May 11, inclusive, whenever the flow in the Ware River exceeded 85 million gallons a day. The flow in the river was not sufficient on any day from May 12 to June 14, inclusive, to permit diversion. In the period from June 15 to October 15, inclusive, in conformity with the requirements of the War Department, no water was diverted. The flow was insufficient also on October 16 to 18 inclusive. Commencing October 18, and until the end of the year, November 30, the daily flow in the river was sufficient to permit diversion, but no diversion was made.

The quantity of water diverted during the year was 9,735,200,000 gallons. The maximum daily diversion occurred on April 2, when 682.4 million gallons were taken into the tunnel. The maximum peak rate of diversion attained was 1,200,000,000 gallons per day. The rate of diversion was momentarily increased to this amount in order to test the maximum capacity of the works for diversion easterly into the Wachusett Reservoir as well as the capacity of the shafts to vent accumulations of air in the tunnel.

The intake works were successfully operated during the diversion season under automatic control with one operator on hand only during the daytime.

During August inspections were made of the shaft, the tunnel near the bottom of the shaft, and the steel bulkhead about 2,250 feet west of the shaft. All were found to be in excellent condition.

Design of Structures

Shaft Vents. — As a result of experience gained in testing the venting of air from the shafts during conditions of capacity flow in the tunnel, designs were made for equipping the shaft cover plates in the floor of the head house over Shaft 4 with hinges and automatic latches and for installing a permanent louver in the south window. Designs were also made for an emergency spillway and vent in the top of Shaft 9, to be completed under Contract 20.

Reservoir Flow Line. — The flow line of Quabbin Reservoir was fixed by the Commission December 29, 1931, at an elevation 530 feet above Boston City Base. This base is approximately 0.8 of a foot below minimum low water in Boston Harbor.

Shaft 12. Swift River Intake. — Studies were continued of the high level intake to adapt the designs to the level established for the flow line.

Main Dam and Dike. — Studies were continued of designs for the main dam and dike. The center lines of both structures were located. Plans were made covering general features of both structures.

Caisson Core Wall at Dike. — Designs were made for a concrete core wall from the original surface to sound rock in the bottom of the valley at the site of the dike to be constructed by sinking a row of caissons, each 9 feet thick by 45 feet long. These caissons are designed to be sealed to the ledge and to each other. Twenty-seven caissons will be required supplemented at each end by a short length of wall constructed in sheeted trench. Studies were made of the economical depth of open-cut trench to be first excavated before starting the sinking of caissons and the bottom of the trench in the deepest portion of the valley was fixed at about 45 feet below the brook level, the remaining distance to ledge being about 80 feet. Each caisson was designed with three 4-foot wells, the two end wells being for handling muck and the central well for handling men. A compressed air lock will be required on each well to seal the caisson to the ledge.

Pumping Ground Water. — From data obtained in sinking the experimental caissons at the main dam and dike sites and by analysis of materials from the caissons, borings and test pits, studies were made of the permeability of the foundation materials at both sites. Designs were made for the installation of pump suction intakes beneath the cutting edge on all four sides of the experimental caisson at the dike to allow the installation of pumps in the completed experimental caisson, so that the lowering of ground water by pumping could be continued after this caisson was sunk. All data on the character of the material overlying the ledge and the lowering of the ground water level were prepared for the benefit of prospective bidders for the construction of the completed caisson core wall. Studies were made of the extent to which the ground water may be still further lowered to facilitate the work of sinking the proposed caissons and of methods best adapted to accomplish this lowering. Designs for the core wall include the sinking of the first two caissons from the present brook level and at a sufficient distance from the exploratory caisson so that pumping plants in all three caissons will effectively lower the ground water level over the entire site.

The design of the core wall provides for the extension of a wall 25 feet above the bottom of the open-cut trench, the final filling of all the caisson well openings with impervious soil and the filling of the open-cut trench over and around the tops of the caissons with impervious soil for a minimum thickness of 110 feet at the original

brook level so that the entire site will be drained and ready for the construction of the dike embankment under a subsequent contract.

Main Dam Control Works. — Studies were continued of the control works to be ultimately installed at the downstream end of the river diversion tunnel and the channel walls of the diversion conduit at the downstream tunnel portal were designed anticipating the requirements of future construction. Provision was made for the future installation in these control works, if desired, of a water turbine so that electric power can be generated from the water required to be released under the provisions of Massachusetts Legislation and the requirements of the War Department. In addition to the 48-inch pipe embedded in the tunnel invert under Contract 30 and previously described, a second 48-inch pipe is designed to be laid subsequently on the invert of the main river diversion conduit after it has been plugged, so that there will be two 48-inch outlets leading from the bottom of two wells in the intake shaft just upstream from the center line of the dam. In the control works at the downstream portal these two 48-inch pipes will be cross-connected so that either or both may be made to deliver to the water wheel or other points of discharge. Provision has been made for a considerable variation in the rate discharged and the quantity will be measured through three Venturi meters designed to accommodate these varying rates, the largest meter, 60 inches x 33 inches, the intermediate, 33 inches x 19 inches, and the smallest, 12 inches x 7 inches. All three meter tubes have been installed as a part of the work under Contract 30.

Photographic Records. — Moving pictures were taken from time to time to illustrate the progress of construction work and to record existing conditions in the Swift River valley.

Protection of Water Supply. — Studies were continued of the removal of sewage from parts of Rutland and Holden and the watersheds of the Ware and Quinapoxet rivers, in conformity with permissive legislation, Chapter 262, Acts of 1932.

Cemetery Development. — Studies were continued of the development of the new cemetery which has been named Quabbin Park Cemetery. Additional driveways and landscaping were planned, making the total area in the first development about 18 acres. The arrangement of lots was determined, totalling 1,602 and averaging 16 x 20 feet. Designs were made of a vault with a capacity of 8 caskets. The vault, with an attractive facing of dark weathered stone masonry, was located on the entrance drive. Lot plans were prepared for permanently recording the assignment of burial lots.

Highway Relocation. — Studies were continued of highway relocations which will be required because of the construction of Quabbin Reservoir.

Railroad Valuation. — Valuation studies were made of that portion of the Athol Branch of the Boston and Albany Railroad which will be affected by the construction of the Quabbin Reservoir.

Wachusett–Coldbrook Tunnel Division — Holden Office

The Wachusett-Coldbrook Tunnel Division continued in charge of the construction of the Wachusett-Coldbrook Tunnel section of Quabbin Aqueduct, the work at all shaft heads, and all work in connection with improvements in the Ware River watershed, also of the maintenance and operation of the Ware River intake works. Commencing December 16, 1931, the division took charge of a portion of the surveys for highway relocation in the Quabbin Reservoir area and field studies of materials and methods of construction of the main dam and dike.

Office Work

Monthly estimates were prepared for Contract 31 and final estimates for Contracts 22, 25, 26, 28, 29 and 31. Geologic samples of the rock excavated from the Wachusett-Coldbrook Tunnel were prepared for permanent record and placed in cabinets on the main floor of the Ware River intake works. Miscellaneous data for record drawings of the Wachusett-Coldbrook Tunnel and appurtenant structures were prepared for the Headquarters office. Daily rainfall and temperature records were continued at the White Valley meteorological station. Topographic maps were made covering various possible routes for the location of a trunk sewer

for diverting from the Ware and Wachusett watersheds the sewage from the U. S. Veterans' Hospital and the State Sanatorium in Rutland and from other institutions in Holden and Rutland. Studies were made of the feasibility of various methods of diverting the sewage. Topographic and real estate plans were prepared, and studies made for relocation of highways which will be made necessary by the construction of Quabbin Reservoir. The division cooperated with the Enfield office in these studies of new highways. Real estate plans were prepared of miscellaneous property in the Ware River watershed. Studies were made of materials, comparative costs and methods of construction of the proposed main dam and dike.

Field Work

Lines and grades were given for construction on Contracts 25, 26, 28, 29 and 31. Topographic surveys were continued in connection with studies of various methods of the disposal of sewage and other wastes from hospitals and other institutions in Holden and Rutland and these surveys were extended covering about 140 acres westerly to Coldbrook. Rod soundings were made to investigate the material along the proposed trunk sewer lines. Topographic surveys covering about 2,400 acres were made in connection with studies for the location of new highways in the Quabbin Reservoir area.

Test pits were dug to determine the occurrence of materials suitable for the road construction.

Real estate surveys were made covering about 2,600 acres in the Ware River watershed including various ponds. The setting of property bounds along and in the vicinity of the Wachusett-Coldbrook Tunnel right of way was completed. A total of 241 stone bounds were set during the year.

The State Department of Public Health continued its cooperation with this division in the analysis of samples of water and sewage effluents. Two chlorinator stations on the Ware River watershed, one to chlorinate the sewage effluent from the treatment plant of the temporary Rutland Prison Camp and Hospital, and the other on Mill Brook below the Rutland State Sanatorium and the Central New England Sanatorium, were continued. These stations were operated from December 4 until June 14, and from October 18 to 22.

A labor force averaging 6 men was employed May 24 to June 8 and July 7 to 26, inclusive, for cooperative work with the State Department of Agriculture — Bureau of Plant Industry, for the eradication of currant and gooseberry bushes for the control of pine blister rust in affected areas owned by the Commonwealth in the Ware River watershed.

Operation of Ware River Intake Works

Operation of the Ware River intake works was continued and the division cooperated with the Headquarters office in miscellaneous tests and inspection of the tunnel as required.

Miscellaneous Construction

Minor alterations were made in the mechanical equipment at the Ware River intake works including the installation of a small make-up oil pump designed to run continuously during the diversion period. At the Wachusett outlet works a small water supply pump and pipe lines to hose connections at various points on the grounds were installed and minor changes were made in the electric transformer connections. In the head house at Shaft 4, following experience gained in the venting of air during capacity flow in the tunnel, hinges and automatic hasps were added to the shaft cover plates and a louver installed in one window. Seeding and grassing around the head house at Shaft 4 which had been omitted from Contract 31 by agreement between the Contractor and the Commission was done by the Commission. Shrubbery and trees from the Metropolitan District Commission nurseries in Stoneham, the State Forest Nursery in Amherst and from private nurseries were transported to the site and transplanted by the Commission April 12 to 26.

A small labor force was employed throughout the year on miscellaneous work in caring for the grounds at the Ware River intake and Wachusett outlet and on filling cellar holes, grading and cleaning up at the sites of buildings removed from the Ware River watershed in the towns of West Rutland, Coldbrook and North Rutland. The average number of men employed in this work was 5 and the maximum 16.

Progress of Contracts

Contract 22. — The work of furnishing and installing the tunnel unwatering pump in Shaft 1 under Contract 22 had been practically completed before the beginning of the year as previously reported. On December 11, 1931, the 900 horse-power motor was disconnected from the pump, removed from the bottom of the shaft and stored on the main floor of the outlet building. The pump, left in the bottom of the shaft, was filled with oil on January 11. Drip covers for the better protection of the motor were attached February 5.

The value of work included in contract estimates during the year was $777.95, the final estimate, dated February 13, being for $13,371.76. The contractor's force averaged 1 man for 4 weeks.

Contract 25. — Contract 25, for constructing the superstructure of the Wachusett outlet building at Shaft 1 in the town of West Boylston was continued to completion. As previously reported, the work had been practically completed before the beginning of the year.

The value of work included in contract estimates during the year was $2,017.08, the final estimate, dated January 6, being for $62,329.23.

Contract 26. — Contract 26, for furnishing and installing power and lighting wiring and electrical equipment at the Wachusett outlet works at Shaft 1 in the town of West Boylston was continued to completion. As previously reported, the work had been practically completed before the beginning of the year.

On December 26, 1931, a float switch was installed for automatic control of the deep well sump pump which keeps the pump shaft unwatered. Grilling around the main switchboard and miscellaneous electrical work was completed on January 5.

The value of work included in contract estimates during the year was $796.59, the final estimate, dated February 3, being for $10,685.21.

Contract 28. — Contract 28, for grading the grounds of the Ware River intake building in the town of Barre was continued to completion. As previously reported, the work had been practically completed before the beginning of the year. The stone walls along the highway were completed January 9. Grading, seeding and grassing were completed May 7.

The value of work included in contract estimates during the year was $3,121.44, the final estimate, dated August 6, being for $8,164.14.

Contract 29. — Contract 29, for grading the grounds in the vicinity of the Wachusett outlet building in the town of West Boylston was continued to completion. As previously reported, the work had been practically completed before the beginning of the year. The stone walls, grading, seeding and grassing were completed in July.

The value of work included in contract estimates during the year was $2,453.93, the final estimate, dated August 6, being for $11,852.68.

Contract 31. — Contract 31, for constructing the superstructure of the head house at Shaft 4 in the town of Rutland was continued to completion. As previously reported, the work had been practically completed before the beginning of the year with the exception of seeding and grassing. Due to the lateness of the season, the Commission approved the contractor's request to omit the seeding from the contract and to deduct $50 from the bid price.

The value of work included in contract estimates during the year was $2,969.52, the final estimate, dated January 6, being for $5,689.02.

Coldbrook–Swift Tunnel Division — Hardwick Office

The Coldbrook-Swift Tunnel Division continued in charge of the construction of the Coldbrook-Swift Tunnel section of Quabbin Aqueduct and of river surveys along the Ware, Swift and Chicopee rivers.

Office Work

Tunnel sections were plotted and excavation volumes computed therefrom. Semi-monthly estimates were prepared for Contract 20. Topographic maps were made for an access road to Shaft 12 which will be required after the reservoir is completed. Work was continued on maps of the area along the Ware River extending above the State Highway bridge in Coldbrook and of various mill ponds on the river below the intake works. Geological field notes and specimens

for a permanent geological record were prepared, of the tunnel driven under Contract 20, in the same manner as was done on the Wachusett-Coldbrook portion of Quabbin Aqueduct.

Field Work

Lines and grades were given for construction on Contract 20. About 485 acres of topography were taken along the Ware River both above and below the intake and about 380 acres in the vicinity of Shaft 12 and the tunnel intake. About 70 acres of Quabbin Lake near the intake were surveyed by sounding. The State Department of Public Health continued its cooperation in the analysis of samples of drinking water used in the different contractors' camps and the investigation of mosquito breeding with reference to the prevention of malaria. Taking of samples of concrete for testing was continued and an analysis was made of rock crushed by the Contractor at the various shafts to determine its fitness for tunnel concrete aggregate. Records were continued of the amount of cement used and required to be used at all points of the work. Photographs of the construction work and of rock formations of geological interest were continued. Geological investigations were continued in connection with the tunnel construction. The division also cooperated with the Enfield office in geological investigations in connection with the diversion tunnel under Contract 30, surveys for the spillway and spillway channel at the main dam and for a new highway west of the proposed reservoir. Samples of mud at various depths in the bottom of Quabbin Lake at the tunnel intake were collected for analysis by the Enfield office laboratory. The division cooperated with the United States Coast and Geodetic Survey in the checking of first-order bench marks along the Springfield-Boston line.

Collection of Stream Flow and Water Power Data

The reading of staff gages, set to determine the head at various water power plants on the Ware, Swift and Chicopee rivers and the fluctuations in the level of the ponds on the Ware and Quaboag river watersheds, was continued, and various staff and automatic gages installed and read as required from time to time. Recording gaging stations at White Valley, Old Furnace, Ware, Red Bridge and Bircham Bend were continued. Current meters were rated from time to time as required.

Investigations of the quality of the water in the Ware River were continued in conjunction with the laboratory at Enfield, the principal work of this office being the determination of the necessary hydraulic data.

Progress of Contracts

Contract 20. — Contract 20, for the construction of the Coldbrook-Swift Tunnel section of Quabbin Aqueduct, through the towns of Barre, Hardwick and Greenwich continued in force throughout the year. This tunnel extends 10.4 miles from the end of the completed Wachusett Coldbrook section to the intake from the east branch of the Swift River at Quabbin Lake in the town of Greenwich.

At the end of the year about 45 per cent of the value of the work was completed. This included the excavation of about 38,499 feet of tunnel and the practical completion of the low level intake. About 600 feet of the approach cut to this intake, breaking through into Quabbin Lake, will be excavated under a subsequent contract. A length of 16,332 feet of tunnel remains to be excavated under this contract. The selection, crushing and screening of tunnel spoil for use as concrete aggregates were commenced at all shafts. Excellent progress was made in the excavation of this hard rock tunnel. The average weekly excavation for the year in 7 headings was 98.3 feet per heading, or 100.7 feet omitting the excavation by bucket hoist prior to the installation of the head frame at Shaft 10. The maximum in one heading was 140 feet in the week ending April 23 in the west heading from Shaft 9. The contractor continued to employ local physicians who made weekly reports on the health of his employees and on the sanitary conditions at each of his camps. The contractor also employed a safety engineer to improve working conditions in the tunnel by periodical inspection and improvement of equipment and enlisting the interest of the workmen.

The value of work included in contract estimates during the year was $2,109,400.52, or a total to November 25, the date of the latest estimate, of $2,489,413.13, of which 90% was approved for payment.

Shaft 9. — Excavation at this shaft has progressed as follows:

Location	To Nov. 30, 1931	Year ending Nov. 30, 1932	Total
East heading	574 ft.	6,013 ft	6,587 ft.
West heading	575 ft.	6,103 ft.	6,678 ft.
Total	1,149 ft.	12,116 ft.	13,265 ft.

Tunnel driving was continued throughout the year. The full face method was used except during the time in which soft rock was encountered requiring timbering, when the heading and bench method was used. In the east heading about 60 feet required permanent timbering and about 638 feet of the tunnel roof was treated with gunite to prevent weathering in the seams and scaling off. In the west heading about 54 feet required permanent timbering, about 82 feet required temporary timbering and about 1,410 feet of the tunnel roof was treated with gunite. In the east heading a seam of trap rock 155 feet through was encountered. The average weekly progress of tunnel excavation for the year was 114.5 feet easterly and 116.2 feet westerly, the maximum progress being in the week ending October 22, when 131 feet were excavated in the east section and 138 feet in the west section. The contractor's force averaged 78 men, the maximum being 87 during the week ending August 27. The average number of persons occupying the camp was 14, the maximum population being 29 during 3 weeks in July.

Work on the construction of a crushing and screening plant for aggregate was started March 15. A crusher driven by a 100-horse-power motor was set up and the crushed stone used to improve access to the shaft. The contractor cooperated with the town of Barre to improve the highway approaches to the shaft. At the end of the year about 15,000 cubic yards of crushed aggregate were accumulated and an aggregate washing plant is being erected. Otherwise than stated above, there has been no material change in plant items during the year. One guniting machine and one pump were added. In all 9 pumps were used in connection with tunnel construction, the largest of them having a rated capacity of 600 gals. per min. under 325-ft. head driven by air pressure. The combined compressor capacity was 1,850 cu. ft. per min.

Shaft 10. — Excavation at this shaft has progressed as follows:

Location	To Nov. 30, 1931	Year ending Nov. 30, 1932	Total
East heading	20 ft.	3,790 ft.	3,810 ft.
West heading	24 ft.	3,773 ft.	3,797 ft.
Total	44 ft.	7,563 ft.	7,607 ft.

Excavation was continued until February 5 with shaft sinking equipment and was resumed 5 weeks later after the installation of a head frame and balanced hoisting skips similar to the equipment previously installed at the other three shafts and described in the last report. The full face method was used. About 147 feet in the east heading required permanent timbering. The average weekly progress of tunnel excavation to February 5, with the bucket hoist, was 34.1 feet easterly and 32.9 feet westerly, the maximum progress being in the week ending January 30, when a total of 97 feet was excavated in both headings. Commencing March 12, the average weekly progress was 93.0 feet easterly and 91.3 feet westerly, the maximum progress being in the week ending September 17, when 123 feet were excavated in the east section and 118 feet in the west section. The contractor's force averaged 64 men, the maximum being 82 during the weeks ending May 28 and November 26. The average number of persons occupying the camp was 23, the maximum population being 33 during the week ending October 22.

Two mucking machines were added during the year. A rock crusher driven by a 10-horse-power motor was set up and in operation April 28 and the crushed stone used to surface the access road to the shaft. At the end of the year about 20,000 cubic yards of crushed aggregate were accumulated. Otherwise than stated above, there has been no material change in plant items during the year. Three pumps were added. In all 10 pumps were used in connection with tunnel construction, the largest of them having a rated capacity of 1,100 gals. per min. under 450-ft. head driven by air pressure. The combined compressor capacity was 1,850 cu. ft. per min.

Shaft 11. — Excavation at this shaft has progressed as follows:

Location	To Nov. 30, 1931	Year ending Nov. 30, 1932	Total
East heading	423 ft.	5,420 ft.	5,843 ft.
West heading	423 ft.	5,770 ft.	6,193 ft.
Total	846 ft.	11,190 ft.	12,036 ft.

Tunnel driving was continued throughout the year. The full face method was used after January 10. About 200 feet in the east heading required temporary timbering. The average weekly progress of tunnel excavation for the year was 103.5 feet easterly and 109.9 feet westerly, the maximum progress being in the week ending January 2, when 115 feet were excavated in the east section and 135 feet in the west section. The contractor's force averaged 74 men, the maximum being 82 during the weeks ending October 8 and November 19. The average number of persons occupying the camps was 27, the maximum population being 36 during the week ending April 9.

Two mucking machines were added during the year. A rock crusher driven by a 60-horse-power motor was set up and in operation March 13. At the end of the year about 45,000 cubic yards of crushed aggregate were accumulated. Otherwise than stated above, there has been no material change in plant items during the year. Four pumps were added. In all 8 pumps were used in connection with tunnel construction, the largest of them having a rated capacity of 300 gals. per min. under 490-ft. head driven by air pressure. The combined compressor capacity was 1,850 cu. ft. per min.

Shaft 12 and Swift River Intake. — Excavation at this shaft has progressed as follows:

Location	To Nov. 30, 1931	Year ending Nov. 30, 1932	Total
East heading	406 ft.	4,924 ft.	5,330 ft.
West heading	167 ft.	5 ft.	172 ft.
Portal	–	89 ft.	89 ft.
Total	573 ft.	5,018 ft.	5,591 ft.

Tunnel driving was continued throughout the year. The contractor designed and built a drag line mucker which was used in the east heading commencing January 24. The motor carriage is about 15 feet long. The rear belt-conveyor is about 40 feet long so that a train of cars can be backed under it. An extension was put on the drag line boom March 7, making it 58 feet long and making the total length about 113 feet. About 119 feet in the east heading required permanent timbering. The average weekly progress of tunnel excavation for the year was 93.5 feet in the east heading, the maximum progress being 136 feet in the week ending August 20.

On April 28 the contractor started to unwater the portal cut. Excavation in the lower intake was resumed on May 25 and the tunnel was excavated easterly from the portal for a distance of 89 feet by the heading and bench method June 2 to 28. No excavation was done in the west heading from Shaft 12, the remaining 58 feet required for holing through being left as a protection against inflow of water from the area of the lower intake.

The work of concreting the lower intake and the cut and cover section leading to the tunnel portal was commenced July 19 and completed October 4, including a length of 10 feet of the tunnel invert and 6 feet of the sidewalls and arch inside the tunnel portal. Riprap and paving at the lower intake were placed during the latter part of September and backfill around the intake structure and the cut and cover section early in October. The material for this backfill was obtained by flattening the side slopes of the portal cut.

The contractor's force averaged 58 men, the maximum being 75 during the weeks ending September 3 and 17. The average number of persons occupying the camps was 26, the maximum population being 49 during the week ending August 27.

One air compressor with a capacity of 750 cu. ft. per min. was added during the year; also a 600 gals. per min. low head pump for use at the lower intake. A rock crusher driven by a 60-horse-power motor was set up and in operation January 15. At the end of the year about 25,000 cubic yards of crushed aggregate were accumulated. An aggregate washing and separating plant was put in operation July 2. Otherwise than stated above, there has been no material change in plant items during the year. The combined compressor capacity was 2,050 cu. ft. per min.

The total work done and materials furnished to date under the principal items of Contract 20 are as follows:

	Shaft 9	Shaft 10	Shaft 11	Shaft 12 and Intake
Earth excavation for shafts (cu. yds.)	84	318	225	*
Rock excavation in shafts and in tunnel within 50 ft. of shafts (cu. yds.)	2,310	3,617	2,660	1,445
Excavation in tunnel, except within 50 ft. of shafts (cu. yds.)	84,736	47,551	75,930	35,923
Shaft and tunnel drainage (lin. ft.)	3,390	2,170	3,138	1,403
Earth excavation in open cut (cu. yds.)	—	2,500	1,803	35,429
Rock excavation in open cut (cu. yds.)	—	435	106	2,121
Forms for concrete linings of shafts (lin. ft.)	178	397	258	—
Concrete masonry in shafts (cu. yds.)	400	929	611	—
Concrete masonry not in shafts or tunnel (cu. yds.)	—	—	1	1,062
Permanent timbering in tunnel (M ft. B.M.)	25	6	—	25
Temporary timbering in tunnel (M ft. B.M.)	6	—	4.5	—
Portland cement (bbls.)	1,106	1,410	898	2,212
Gunite protective coating of tunnel rock (lin. ft.)	1,943	—	—	—
Refilling and embanking (cu. yds.)	—	1,625	—	2,753
Miscellaneous cast iron, wrought iron and steel (lbs.)	23,400	3,415	—	5,911

*Included in item, "Earth excavation in open cut."

Electric power for all contract requirements was purchased by the contractor. The total consumed at the different shafts was as follows:

	K.W.H.
Shaft 9	2,167,200
Shaft 10	2,718,800
Shaft 11	2,577,600
Shaft 12	1,635,800
Total	9,099,400

Contract 24. — Contract 24, for constructing the superstructure of the building for the Ware River intake works at Shaft 8 of the Wachusett-Coldbrook Tunnel in the town of Barre was continued to completion. As previously reported, the work had been practically completed before the beginning of the year.

The value of work included in contract estimates during the year was $279.64, the final estimate, dated January 6, being for $70,114.04.

Quabbin Reservoir Division — Enfield Office

The Quabbin Reservoir Division, previously designated as the Swift River Reservoir Division, continued in charge of the field work in the Swift River valley in connection with the proposed Quabbin Reservoir including topographic and real estate surveys, cemetery removal work, and the soil testing and water analysis laboratories. The division also continued in charge of construction work at the main dam and dike sites, Quabbin Park Cemetery, and the Ware-Belchertown highway relocation.

Miscellaneous Office Work

Semi-monthly estimates for Contract 21, monthly estimates for Contracts 23, 30, 32 and 34, and final estimates for Contracts 21, 32 and 34 were prepared. Topographic and real estate plans were prepared and studies made for relocation of highways which will be necessary west of Quabbin Reservoir. Topographic plans were completed for the layout of roadways in Quabbin Park Cemetery, and revised topographic plans of the dike site were made. Photographs of the progress of construction carried on under the supervision of this and other divisions were taken by this division. Meteorological records were continued in Enfield.

Miscellaneous Field Work

Lines and grades were given for construction on Contracts 21, 23, 30, 32 and 34. A detailed topographic survey was made for use in a contract for the caisson core wall at the dike site. The lowering of the ground water level at the dike site under Contract 32 was, at the completion of the contract, continued by the division, using rented pumping equipment installed in the completed exploratory caisson and in the adjacent sump; daily readings of ground water level in numerous test wells were taken. Electric wiring and pumping equipment was installed in the completed experimental caisson at the dam site and the pumps were operated for 2 months commencing June 25, as an experiment in lowering the ground water level. Test pits were dug in connection with the investigation of the porosity of foundation materials at the main dam and dike and of materials for use in the construction of the proposed embankments. Topographic and real estate surveys and cross sections were made for the location of new highways west of Quabbin

Reservoir and test pits were dug to determine materials suitable for their construction. Subsurface investigations were made by pipe casings and test pits at and near the site of the proposed main dam spillway and spillway channel.

Reservoir — General

Topography. — No progress was made during the year on the general topographic maps within and adjacent to the proposed reservoir. To date 25,970 acres or 40.6 square miles have been surveyed. About 24,200 feet of the drainage divide were surveyed.

Real Estate. — Additional property described in applications by owners for sale of real estate was located and sketches made showing the approximate location. Comprehensive real estate surveys and analyses and descriptions of deeds were continued. Real estate surveys during the year cover 579 acres, making a total to date of 58,889 acres or 92.01 square miles. Of this total, 57,745 acres have been plotted at a scale of 1 inch = 200 feet. No additional final tracings were made. Preliminary taking plans were made covering about 30,000 feet of highway location surveyed in Belchertown and Pelham.

Photography. — The photographing of buildings and cemetery lots within the area to be affected by the proposed reservoir and the making of record prints were continued. During the year 73 photographs of buildings, 99 of cemetery lots, and 246 of the progress of construction carried on under the supervision of this and other divisions were taken. 220 photographs of property in the Ware River watershed were also taken.

Cemetery Removals. — With the completion of Quabbin Park Cemetery and the prohibition of further interments in existing cemeteries in the reservoir area, interments in the new cemetery and general removal of bodies from existing cemeteries were begun. The removal of bodies, headstones and monuments has been done by this division with labor engaged directly for this work. Equipment for the work of removing and resetting monuments was supplemented during the year by a portable concrete mixer. During the year work has progressed as shown in the following table:

QUABBIN PARK CEMETERY

	To Nov. 30, 1931*	Year ending Nov. 30, 1932	Total
Burial lots assigned in exchange	0	208	208
Burial lots purchased	0	1	1
Number of releases executed of rights in old lots in Quabbin Reservoir area — to Q. P. Cemetery	0	28	28
Number of releases executed of rights in old lots in Quabbin Reservoir area — to other cemeteries	80	31	111
Bodies removed from Quabbin Reservoir area — to Q. P. Cemetery	0	62	62
Bodies removed from Quabbin Reservoir area — to other cemeteries	527	171	698
Burials, not reinterments	0	9	9
Headstones moved — to Q. P. Cemetery	0	42	42
Headstones moved — to other cemeteries	235	82	317
Monuments moved — to Q. P. Cemetery	0	7	7
Monuments moved — to other cemeteries	95	22	117

*Quabbin Park Cemetery was not completed and ready for use until August 25, 1932.

Fire Protection. — The fire fighting equipment housed at Enfield was continued in readiness for service at all times. Five assistants in the division office were reappointed as deputy forest wardens in each of the towns affected by the reservoir. The equipment and personnel responded during the year to calls for assistance at 8 forest fires which burned over a total area of 326 acres. The apparatus also responded to fires in 7 buildings.

Laboratories

Soil Testing Laboratory. — The work of exploring, collecting and testing materials to determine their suitability for use in the construction of the proposed main dam and dike was continued. New equipment was added to the laboratory as testing methods were expanded to include new studies and to keep pace with current developments in soil engineering. Investigations were continued of the extensive and deep deposits of glacial till forming the ground moraine overburden

on the west side of Beaver Brook valley north of the dike site and on the west side of the Swift River north of the main dam site. The investigations included studies of deposits of modified drift on the east side of the river above the main dam site. In connection with the construction of the Swift River diversion works, tests were continued of top soils for the impervious portions of the cofferdams. Tests were also made of top soils, in areas north and east of Enfield, available for use in the impervious portions of the proposed cut-offs at the dam and dike. In connection with percolation studies of materials in the main dam and dike foundations, tests were made of permeability, porosity, and grain size of samples from the exploratory caissons, open cuts and test pits; and in cooperation with the Headquarters office all boring samples were analyzed and classified for size distribution.

Chemical and Bacteriological Laboratory. — The collecting and analyzing of water samples in preparation for records and reports were continued in cooperation with the Headquarters office and with assistants from the Coldbrook-Swift Tunnel Division. Samples of the water supplies of contractors engaged on work in this and other divisions and of miscellaneous supplies on property controlled by the Commission were collected and analyzed periodically. Studies were made of the chemical stability of materials found in the bottom of Quabbin Lake near the intake to Quabbin Aqueduct.

Miscellaneous Construction

Work of clearing the sites of the main dam and dike was done by labor employed by the Commission.

Work of developing Quabbin Park Cemetery under Contract 34 was supplemented by clearing, grubbing and grading the cemetery area. In clearing, selected trees and bushes were left standing to retain the natural beauty of the cemetery development. New planting included 390 white pines and 75 red pines transplanted from the reservoir area, and 50 arbor vitae, 100 Norway and blue spruce and 54 red pines from nursery stock.

A concrete receiving vault having a capacity for 8 bodies was constructed near the entrance to the cemetery. Dark weathered stones were gathered from walls on property of the Commonwealth for use in facing the entrance walls, framing the heavy steel doors.

A water supply for the cemetery was installed consisting of a collecting well on property of the Commonwealth, about 6,000 feet of ¾-inch distribution pipe, a pressure tank located at a high point in the cemetery and 16 self-closing faucets located at convenient points along the cemetery roadways.

Two hundred tons of trap rock crusher screenings were applied to the surfaces of driveways in Quabbin Park Cemetery. One hundred tons were purchased and stored for future maintenance of the surface.

The average force employed on cemetery development during 33 weeks ending August 20 was 12 men, the maximum being 25 during the week ending June 18.

Progress of Contracts

Contract 21. — Contract 21, for constructing a relocated portion of the Ware-Belchertown highway in the towns of Ware and Belchertown was continued to completion. The Department of Public Works cooperated in the construction of this new state highway and paid a portion of the cost, namely the cost of surfacing and guard rails. All excavation and embankment to sub-grade was completed December 11, 1931, except a small amount remaining at the approaches to the bridge across the Swift River. Gravel sub-base was also completed at that time for about 12,000 feet at the west end, 1,650 feet at the east end, and at connections with two main crossroads. This included all sections required to be left passable for winter traffic. Both abutments, the two piers, and the westerly deck were completed before February 2. Work on the roadway was stopped for the winter from December 11 to April 13 and on the bridge from February 2 to March 30. The bridge was completed on May 26.

At the start of the work in the spring, three shovels were operated in gravel borrow pits and the placing of gravel base and shoulders was advanced rapidly. Broken stone for the roadway surface was received by rail at the West Ware siding where the Contractor had installed unloading equipment. Placing the

stone was started on May 1 and carried on continuously from both ends to completion near the midpoint at West Ware, July 15. An average of 600 tons per day of this surface material was placed. The top course was placed 2½ inches thick throughout. The excellent character of the gravel sub-base made it possible to decrease the thickness of the broken stone base course from 4½ inches to 3½ inches for nearly three quarters of the entire length. Bituminous asphalt used to penetrate the broken stone was applied at the rate of 2¼ gallons per square yard followed by a seal coat at ½ gallon per square yard, except that on grades of 3% or more a single application was made at 2¾ gallons per square yard. The installation of cable guard rails was started on July 11, and completed on August 22.

Entrance drives to various properties along the highway were provided and side slopes in the vicinity of dwelling houses, Quabbin Park Cemetery and other conspicuous points, including the slopes of two heavy cuts, were covered with loam and seeded. In addition all side slopes and cuts and fills were seeded. The approaches of two intersecting highways were treated with applications of tar. At the east end to improve the intersection with the Ware-Enfield road, a long radius connection, 290 feet long, was constructed and surfaced with bituminous macadam the same as the main highway and a length of 650 feet of the Ware-Enfield road was re-surfaced.

The broken stone surface is 24 feet wide with 3-foot gravel shoulders. The maximum grade is 6% and the sharpest curve has a radius of 1,100 feet.

The Department of Public Works assigned an inspector to the work to inspect the placing of the roadway surface and guard rails, and the general cleaning up of the work.

The value of work included in contract estimates during the year was $169,024.36, the final estimate, dated October 11, being for $225,707.19, of which $95,726.94 was paid by the Department of Public Works. The contractor's force averaged 45 men for 32 weeks, the maximum being 133 on December 2, 1931.

Important items of plant added during the year for the work of surfacing were one stone unloader, one distributor mounted on truck chassis and one crane with ½-cu. yd. bucket.

The total work done and materials furnished to date under the principal items of Contract 21 are as follows:

Roadway earth excavation	86,078 cu. yds.
Bridge excavation	1,644 " "
Ledge excavation	7,090 " "
Earth borrow	43,991 " "
Rubble concrete masonry	998 " "
Plain concrete masonry	225 " "
Reinforced concrete masonry	730 " "
Broken stone	28,333 tons
Bituminous material	201,400 gals.
Gravel borrow	30,440 cu. yds.
Fine grading	181,629 sq. yds.
Cable guard rails	17,058 lin. ft.
Trench excavation	4,512 cu. yds.

Contract 23. — Contract 23, for making borings in the towns of Belchertown, Enfield, Ware, Greenwich and Hardwick continued in force throughout the year. The work was practically confined to the exploration of overburden in the vicinity of the main dam and dike sites.

The value of work included in contract estimates during the year was $11,349.18 or a total to November 10, the date of the latest estimate, of $30,773.25, of which 90% was approved for payment. The contractor had one drilling rig in operation during the year and employed an average of 2 men.

Contract 30. — Contract 30, for constructing the stream control works at the main dam of Quabbin Reservoir in the towns of Belchertown, Enfield and Ware continued in force throughout the year. Rock excavation in open cut at the downstream portal was started on December 3, 1931. All work of tunnel excavation was carried on from the downstream portal. Commencing January 4, a top heading from about 2 feet below the springing line of the arch to the roof was excavated for a distance of 840 feet followed by a pilot heading about 6 feet square to the upstream portal, holing through on April 8. This upper drift was then enlarged and completed about April 20. Excavation of the lower bench was started at the downstream portal April 30 and completed June 26. A small

CONTRACT 30. — Main Dam River Diversion Tunnel, Downstream Portal, Drill Carriages Used in the Tunnel Excavation.

CONTRACT 32. — In the Working Chamber of the Exploratory Caisson at the Dam Site after Underpinning from the Cutting Edge to Ledge, 102 feet below the surface.

quantity of rock excavation near the downstream portal as well as a considerable quantity of earth excavation in the downstream channel was left as a ramp for handling materials out of the tunnel by truck until September 15 when excavation of the downstream channel was again started and, together with the remaining rock excavation in the downstream portal, completed November 16 except for breaking through to the river.

Excavation of rock in the upstream approach cut was continued. The upstream portal was moved back into the hill about 110 feet and the excavation for the cut and cover section of the conduit increased accordingly on account of the occurrence of a disintegrated condition of the ledge surface. This excavation was completed on June 28.

At the shaft, earth excavation was started May 24, and on April 19, rock excavation was started with a hole about 8 feet square as an upward drift from the tunnel. This hole broke through to the surface on June 9 and the remaining shaft excavation was carried on intermittently and completed on August 12.

Sound rock was encountered for the entire distance between portals and no timbering was used. Drilling was done from drill carriages mounted on automobile truck bodies and mucking by a 1-cubic yard electrically-operated shovel. Muck was hauled out by gasoline-operated trucks. The average progress in the top heading was 8.6 feet or 163 cu. yds. per day and in the bench excavation 16.7 feet or 234 cu. yds. per day. A trench about 7 feet wide was excavated in the tunnel floor for the placement of a steel pipe from a riser in the shaft to the downstream portal. This pipe was lined with gunite in sections alongside the trench before placing, 48 inches inside diameter. The installation was completed September 7, and satisfactory tests for tightness made.

Materials from the earth excavation suitable for concrete aggregate were stored and a plant for crushing, screening and washing this material was operated from June 17 to October 14. The wash water was discharged into a settling basin, only the overflow from the basin entering the river. All fine and coarse aggregates used on the work were obtained from this plant. Cement was delivered to the job first in bags on June 25. From August 13 to November 30, for practically all of the major concreting operations, cement was delivered in bulk. For the greater part of the work of concreting, aggregates were belt-conveyed to an aggremeter located in the upstream channel. Materials were conveyed by trucks containing four batches of 1 cubic yard each to 1-cubic yard mixers located near the point of deposit. For tunnel sidewalls and arch the mixed concrete was delivered through pneumatic conveyers and placers. Lining of the approach channel was commenced July 1. Tunnel lining was commenced August 12 and completed November 4. All concrete work, including the cut and cover section of the conduit, the entrance portal, tunnel invert sidewalls and arch, concrete walls and Venturi tubes at the outlet, was completed, except the lining of the shaft above elevation 394 and a small portion of the lining of the approach channel. The maximum daily output of concrete was 380 cu. yds. on August 5 and 6, using two mixers.

The construction of rolled cofferdam embankments from materials obtained from the various excavations was stopped for the winter December 3, 1931, resumed September 15 and completed about November 15. Surplus rock from the tunnel excavation not used in constructing the cofferdams was placed in storage piles downstream for subsequent use in the toes of the dam. Placing of rolled impervious blanket on the upstream face of the upstream cofferdam was carried to completion coincident with the cofferdam fill, material being secured from storage piles from the stripping operations and from a borrow area above the dam site. Some of the material excavated from the discharge channel was deposited as backfill over the cut and cover section of the conduit and puddled to insure a compact fill. The maximum number of trucks used was 14.

At the end of the year about 90% of the work was completed, the work remaining to be done consisting of completing the shaft lining, paving around the upstream portal and breaking through to the river both upstream and downstream.

The value of work included in contract estimates during the year was $405,526.65 or a total to November 10, the date of the latest estimate of $471,484.15, of which 90% was approved for payment. The contractor's force averaged 75 men, the maximum being 166 on July 21 and 22. The average number of persons occupying

the camp was 36, the maximum population being 60 during the two weeks ending August 1.

The following items of plant equipment were added during the year:

1 Crushing, screening and washing plant
1 1¼-cu. yds. travelling crane
1 Aggremeter
2 1-cu. yd. mixers
2 14-cu. ft. pneumatic concrete placers

The total work done and materials furnished to date under the principal items of Contract 30 are as follows:

Excavation in shaft and tunnel	38,000	cu. yds.
Earth excavation in open cut	275,700	" "
Rock excavation in open cut	23,430	" "
Refilling and embanking compacted in 6-inch layers	130,300	" "
Other refilling and embanking	110,740	" "
Concrete masonry in tunnel and open-cut conduit	12,520	" "
Portland cement	27,202	barrels

Contract 32. — Contract 32, for constructing two exploratory caissons, one at the main dam and one at the dike of Quabbin Reservoir, in the towns of Enfield and Ware, was continued to completion. Sinking the caisson at the dam site was continued by open dredging to December 5, 1931, and thereafter under compressed air until bedrock was reached on January 9 at elevation 313.8, a depth of about 70 feet below the river level, 86.2 feet below the bottom of the open-cut trench and 102 feet below the original surface. The caisson was left projecting 11.6 feet above the bottom of the open-cut trench. The caisson was landed practically plumb, the maximum variation in elevation between the four corners of the 12 x 32 foot-section being 0.2 foot. The rate of sinking was 11.68 feet per 24-hour day during the actual sinking by open dredging and 2.13 feet per 24-hour day during actual sinking under air pressure. Concrete underpinning walls were built from the cutting edge to sound ledge at all points, all loose and seamy rock removed, pipes placed for subsequent drilling of grout holes and a concrete seal was poured on January 14 to a height about 12 feet above the cutting edge. Grouting operations were completed February 9. The maximum air pressure used was 33 lbs.

Attempts to reduce the pressure by experimental pumping from a central pump well connected to screen chambers in the sides and ends of the cassion indicated that air escaping from under the cutting edge clogged the screens with fine material to such an extent that the ground water level could not be lowered materially during the sinking operations. After the caisson was sunk, pump inlets and screens were cleaned of the fine material and a flow of 650 gallons per minute into the pump well was obtained.

Equipment used at the dam site was removed to the dike site, the shoe of the dike caisson placed practically at the original surface only about 1 foot above the ground water level and concrete poured to a height of 25 feet on February 8. The caisson was sunk to a depth of about 9 feet by open dredging. The coarse compact nature of the material encountered at this point, 8 feet below the water level, made it necessary to place the caisson under air. Sinking under air was started February 27, and reached a depth of 63 feet on April 14. The rate of sinking to this depth under air was 1.97 feet per 24-hour day of actual sinking.

Experiments in pumping from a central well through screen chambers in the sides and ends of the caisson were continued at the dike caisson but the perforated steel plate screens, flush with the concrete surface, used at the dam site were omitted, the screen pockets being filled with graded material in direct contact with the outside earth. However, the experience at the dam site was repeated in the clogging of the intakes by fine material apparently due to air escaping from beneath the cutting edge. Furthermore, the screen openings proved to be a disadvantage on account of boulders crowding into them and increasing the frictional resistance.

Since the estimated depth to bedrock was 123 feet below the ground water level, a sheeted pump sump about 26 feet square was excavated at a point about 100 feet from the caisson to a depth about 50 feet below the ground water level, in which pumps for lowering the ground water level could be installed. To facilitate the excavation of this pump sump, the sinking of the caisson was stopped, and pumps were installed in one of the working chambers and used to lower the ground water level ahead of the sump excavation. Upon completion of the sump, pumps

were installed therein and operated continuously from May 27 until the caisson was completed at a rate of about 1300 gallons per minute.

After these pumps were put in operation and before sinking the caisson was resumed, wells were excavated by cribbing at the sides and ends of the caisson to uncover the screen chambers. These were filled with concrete except for small pipe openings and all baffle plates and other obstructions tending to increase the frictional resistance to sinking were removed. Sinking under air was continued, generally through coarse water-bearing gravel with many boulders, from June 7 to July 21, when the caisson landed on sound ledge at elevation 292.4, after sinking a depth of 123.9 feet. The caisson was left projecting about 8 feet above the surface. It was landed inclined 12 inches in the total height of 132 feet and about 12 inches average to one side of the line as given. The average rate of sinking from the 63-foot depth was 2.32 feet per 24-hour day.

Before sealing the caisson to ledge, four pump intakes or chambers filled with graded gravel were constructed below the cutting edge, one on each side and each end of the caisson. Pipe connections were placed through the concrete seal from these chambers to one of the wells in the caisson to be used as a pump well. The walls were then underpinned to sound ledge and pipes for subsequent drilling of grout holes were placed. The concrete seal was poured on July 29 to a height about 12 feet above the cutting edge. The maximum air pressure reached 48 lbs. Grout holes were drilled but grouting was left to be done under a subsequent contract.

The connection by piping of a caisson well with the intakes under the cutting edge was made for use primarily in lowering the ground water level during a subsequent contract. Connections were also made so that pumps in this well could take water from the intake pipes originally provided in the sides and ends of the caisson. Electric wiring and piping was installed to provide for the installation of two vertical motor-driven pumps under a subsequent contract. In order to continue the lowering of the ground water level in preparation for such a contract, one pump with a capacity of 1200 gallons per minute was installed and operated and after the completion of the contract its operation was continued by labor employed on force account. This pump was transferred to the caisson from the pump sump leaving a pump of 500 gallons per minute capacity in the sump which was also continued in operation after the completion of the contract.

The value of work included in contract estimates during the year was $150,340.83, the final estimate, dated September 20, being for $162,838.33. The contractor's force averaged 33 men, the maximum being 70 on July 9. No important new items of plant were added during the year.

Contract 34. — Contract 34, for constructing driveways in Quabbin Park Cemetery in the town of Ware was continued to completion. The work originally contemplated, of which 80% had been completed at the beginning of the year, was extended by the addition of 2,000 feet of roadway in an addition to the cemetery development. Work was resumed on April 12, following the winter shut-down. Clearing of the driveway areas in the cemetery extension was completed April 17. Top soil was stripped with a ½-cubic yard gasoline shovel and stored for later use in covering the side slopes, from April 13 to April 16. Grading and excavation of the cuts to sub-grade were completed April 27, the material being hauled to the embankment fills in trucks. The entire work including culverts and surfacing of the roadway, covering side slopes with loam, and storing surplus loam for subsequent use, was completed May 18.

The value of work included in contract estimates during the year was $5,209.02, the final estimate, dated October 8, being for $7,842.94. The contractor's force averaged 14 men for 5 weeks, the maximum being 23 on April 26.

Contract 35. — Contract 35, for the purchase of electricity for experimental work at the dam site was executed June 2 with the New England Power Company. Electric power was purchased for use in experimental pumping. The total power furnished was 22,675 kilowatt-hours, costing $453.50.

Contract 37. — Contract 37, for the purchase of electricity for continuing pumping operations begun under Contract 32 at the dike site in Enfield was executed September 21 with the New England Power Company. The work of pumping was taken over by the division on September 21 and continued to date with electric

power purchased under this contract. The total power furnished was 95,500 kilowatt-hours.

Geological Data

Chapter 321, Acts of 1927, provides that "The Commission shall collect and publish in its reports such information as to the geology of the region in which any of the works which it is authorized to construct may be located as may be of value in connection with the geological history of the State." Such information is being prepared for publication in a subsequent report.

List of Drawings and Tables Appended Hereto

Location of Real Estate Acquired for Quabbin Reservoir.
Takings of Real Estate (and Water Rights).
Status of Contracts Completed between Nov. 30, 1930 and Nov. 30, 1932.
Status of Contracts in Force on Nov. 30, 1932.

For General Plan of Metropolitan Water Supply and Key Plan and Profile of Wachusett-Coldbrook Tunnel, see Second Annual Report. For data on Contracts Completed Prior to Nov. 30, 1930, and for Key Plan and Profile of Coldbrook-Swift Tunnel, see Sixth Annual Report.

Respectfully submitted,
Frank E. Winsor, *Chief Engineer.*

20 Somerset Street, Boston, Mass.
December 15, 1932.

FINANCIAL STATEMENT OF THE METROPOLITAN DISTRICT WATER SUPPLY COMMISSION

EXPENDITURES AND DISBURSEMENTS FOR THE FISCAL YEAR AND FROM JULY 28, 1926, THE DATE OF THE APPOINTMENT OF THE COMMISSION

GENERAL OVERHEAD

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
ADMINISTRATION, *Commissioners' Office:*		
Salaries, Commissioners	$10,500.00	$66,612.80
Salaries, Clerical	11,840.83	60,946.24
General Legal Expense	0.00	1,377.80
Furniture and Fixtures	80.22	2,162.78
Rent and Upkeep	2,162.88	13,716.87
Automobile Purchase	0.00	1,988.90
Automobile Maintenance	325.68	1,927.02
Miscellaneous Expense (undistributed)	1,061.33	10,045.99
Advertising	749.93	5,043.52
Printing and Blueprinting	777.78	5,422.77
Stationery and Office Supplies	219.05	1,312.17
Postage	140.50	603.05
Total Administration, Commissioners' Office	$27,858.20	$171,159.91
ENGINEERING, *Headquarters' Office:*		
Salaries, Engineering	$78,552.01	$471,692.10
Salaries, Clerical	9,400.49	56,078.90
General Consultant Expense	8,640.59	107,613.93
General Legal Expense	0.00	53,160.29
Furniture and Fixtures	433.38	12,116.19
Laboratory Equipment	0.00	1,961.00
Laboratory Supplies	0.00	2,071.94
Rental of Equipment	0.00	3,370.02
Engineering Instruments	53.90	1,027.96
Rent and Upkeep of Boston Office	11,407.28	62,954.60
Rent and Upkeep of Springfield Laboratory	0.00	3,950.54
Automobile Purchase	0.00	2,675.60
Automobile Maintenance	325.77	2,816.20
Special Experiments	0.00	2,304.63
Miscellaneous Expense (undistributed)	860.97	18,726.25
Printing and Blueprinting	557.43	12,644.06
Stationery and Office Supplies	468.80	3,377.42
Postage	255.00	1,104.58
Total Engineering, Headquarters' Office	$110,955.62	$819,646.21
UNASSIGNED:		
Unassigned Supplies and Equipment	$–38.79	$604.72
Total Unassigned	$–38.79	$604.72
Total General Overhead	$138,775.03	$991,410.84

Distribution of General Overhead

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
Administration, *Commissioners' Office:*		
Wachusett-Coldbrook Tunnel	$3,362.28	$62,776.14
Coldbrook-Swift Tunnel	2,307.22	13,177.95
Quabbin Reservoir	10,763.44	69,992.93
Main Dam and Dike	11,425.26	16,522.61
Southern Sudbury Emergency Supply	0.00	8,690.28
Total Administration, Commissioners' Office	$27,858.20	$171,159.91
Engineering, *Headquarters' Office:*		
Wachusett-Coldbrook Tunnel	$12,760.47	$258,024.24
Coldbrook-Swift Tunnel	9,510.26	56,052.86
Quabbin Reservoir	43,020.41	406,745.19
Main Dam and Dike	45,664.48	65,415.95
Southern Sudbury Emergency Supply	0.00	33,407.97
Total Engineering, Headquarters' Office	$110,955.62	$819,646.21

Wachusett-Coldbrook Tunnel Section of Quabbin Aqueduct, Ware Supply

General Overhead:		
Administration	$3,362.28	$62,776.14
Engineering	12,760.47	258,024.24
Total General Overhead	$16,122.75	$320,800.38
Engineering:		
Salaries, Engineering and Clerical	$10,334.34	$383,380.54
Consultant Expense	390.19	7,574.16
Labor	938.00	1,432.00
Furniture and Fixtures	559.87	2,240.89
Engineering Instruments	45.14	7,739.81
Rent and Upkeep	2,126.70	12,726.89
Automobile Purchase	1,455.00	9,948.47
Automobile Maintenance	1,796.35	14,308.09
Contracts for Investigations and Surveys	0.00	18,640.69
Miscellaneous Expense (undistributed)	1,518.66	8,691.29
Advertising	0.00	6.05
Printing and Blueprinting	55.71	847.14
Stationery and Office Supplies	347.40	2,549.85
Postage	42.02	318.84
Total Engineering	$19,609.38	$470,404.71
Real Estate, *General Construction:*		
Legal and Expert Expense	$664.22	$5,497.14
Consultant Expense	61.26	455.66
Labor	230.75	1,137.30
Miscellaneous Expense (undistributed)	338.58	584.10
Printing and Blueprinting	2.55	43.48
Purchases and Settlements	5,611.00	120,700.71
Taxes	322.90	2,900.87
Maintenance of Real Estate	45.74	563.88
Police Protection, Labor	6.00	31.00
Fire Protection, Equipment	0.00	30.97
Special Agents, Salaries	2,460.00	10,653.00
Furniture and Fixtures	0.00	117.67
Automobile Purchase	319.00	1,222.50
Automobile Maintenance	272.44	1,774.41

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
Miscellaneous Expense (undistributed)	$204.84	$1,022.17
Printing and Blueprinting	0.00	7.89
Stationery and Office Supplies	3.43	3.43
Postage	2.00	12.36
Total Real Estate	$10,544.71	$146,758.54
WARE WATERSHED PROTECTION:		
Salaries, Engineering and Clerical	$12,312.08	$45,866.05
Legal and Expert Expense	1,163.06	9,661.12
Consultant Expense	0.00	763.70
Labor	1,967.91	8,318.79
Contracts	0.00	4,395.51
Miscellaneous Expense (undistributed)	934.80	2,200.83
Printing and Blueprinting	33.99	288.99
Stationery and Office Supplies	6.00	6.00
Installed Equipment	3.06	2,046.96
Purchases and Settlements	49,293.13	569,101.97
Taxes	886.04	11,893.37
Maintenance of Real Estate	0.00	132.81
Automobile Maintenance	559.85	581.48
Total Ware Watershed Protection	$67,159.92	$655,257.58
WARE DIVERSION DAMAGES:		
Salaries, Engineering and Clerical	$13,001.54	$48,750.88
Legal and Expert Expense	979.33	1,811.57
Consultant Expense	7,815.80	10,805.45
Labor	140.70	2,174.03
Laboratory Equipment	4.39	106.86
Laboratory Supplies	31.14	59.02
Engineering Instruments	25.38	491.98
Rental of Equipment	5.00	182.25
Automobile Maintenance	1,164.25	1,234.77
Contracts for Investigations and Surveys	0.00	63.27
Materials of Construction	0.00	136.51
Miscellaneous Expense (undistributed)	808.42	5,376.20
Printing and Blueprinting	130.56	256.20
Postage	0.00	5.75
Purchases and Settlements	25,450.00	47,950.00
Total Ware Diversion Damages	$49,556.51	$119,404.74
PERMANENT CONSTRUCTION — CONSTRUCTION CONTRACTS:		
Contract No. 4, Sinking Shaft 5 and driving 1,367 linear feet of tunnel	$0.00	$290,581.99
Contract No. 8, Sinking Shafts 6 and 7 and driving 3,062 linear feet of tunnel	0.00	456,784.26
Contract No. 10, Construction and maintenance of Transmission line for Wachusett-Coldbrook tunnel contracts	0.00	119,547.39
Contract No. 12, Sinking Shafts 2, 3 and 4 and driving 3,810 linear feet of tunnel	0.00	632,727.44
Contract No. 14, Constructon of East Portion of Wachusett-Coldbrook Tunnel and Shaft 1	10,000.02	3,515,787.08
Contract No. 17, Construction of West Portion of Wachusett-Coldbrook Tunnel and Shaft 8	0.00	4,127,094.19

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
Contract No. 18, Furnishing Iron Castings for the Ware River Intake Works	$0.00	$19,431.07
Contract No. 19, Construction of Dam and Substructure of Intake Building for the Ware River Intake Works	0.00	285,580.49
Contract No. 22, Furnishing and Installing an Unwatering Pump in Shaft 1	2,037.33	13,371.76
Contract No. 24, Construction of Superstructure of Intake Building for the Ware River Intake Works	7,263.08	70,114.04
Contract No. 25, Construction of Superstructure of Outlet Building at Shaft 1	8,048.30	62,329.23
Contract No. 26, Furnishing and Installing Power and Lighting Wiring and Electrical Equipment at the Outlet Works at Shaft 1	1,785.45	10,685.21
Contract No. 28, Grading the Grounds at the Ware River Intake Building	3,625.71	8,164.14
Contract No. 29, Grading the Grounds at the Outlet Building at Shaft 1	3,393.81	11,852.68
Contract No. 31, Construction of the Superstructure of the Head House at Shaft 4	3,241.47	5,689.02
Total Contracts	$39,395.17	$9,629,739.99
PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:		
Installed Equipment	$738.33	$60,304.23
Temporary Equipment	0.00	5,013.60
Labor	1,043.60	2,138.35
Contracts for Equipment for Surveys	0.00	898.34
Maintenance of Partially Completed Structures	2,104.01	5,009.99
Maintenance of Grounds	2,031.51	2,031.51
Purchase of Plants, Trees and Shrubbery	614.63	614.63
Rental of Equipment	0.00	7.00
Miscellaneous Expense	197.83	9,436.21
Total	$6,729.91	$85,453.86
Total Wachusett-Coldbrook Tunnel Ware Supply	$209,118.35	$11,427,819.80
SPECIAL INVESTIGATION — POLLUTION OF WARE AND QUINAPOXET WATERSHEDS. (Expenditures under Chapter 66, Acts of 1931)		
Salaries, Engineering	$0.00	$986.67
Miscellaneous Expense	0.00	1,009.32
Total Special Investigation	$0.00	$1,995.99
COLDBROOK–SWIFT TUNNEL SECTION OF QUABBIN AQUEDUCT		
GENERAL OVERHEAD:		
Administration	$2,307.22	$13,177.95
Engineering	9,510.26	56,052.86
Total General Overhead	$11,817.48	$69,230.81
ENGINEERING:		
Salaries, Engineering and Clerical	$47,768.58	$106,581.20
Labor	212.20	284.45
Furniture and Fixtures	13.97	665.31
Engineering Instruments	240.74	4,211.45
Rent and Upkeep	1,396.32	6,559.82

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
Automobile Purchase	$985.00	$7,427.97
Automobile Maintenance	1,415.49	11,851.86
Contracts for Investigations and Surveys	0.00	13,525.66
Materials of Construction	0.00	2.25
Miscellaneous Expense (undistributed)	825.05	5,803.70
Printing and Blueprinting	52.56	486.03
Stationery and Office Supplies	221.02	1,595.37
Postage	48.99	269.29
Total Engineering	$53,179.92	$159,264.36
REAL ESTATE:		
Legal and Expert Expense	$116.19	$2,890.47
Labor	3.20	12.20
Miscellaneous Expense (undistributed)	0.00	27.16
Printing and Blueprinting	0.14	34.87
Postage	0.00	5.68
Purchases and Settlements	4,610.00	18,025.00
Taxes	106.15	128.65
Maintenance of Real Estate	0.00	9.25
Fire Protection, Equipment	0.00	60.86
Total Real Estate	$4,835.68	$21,194.14
PERMANENT CONSTRUCTION — CONSTRUCTION CONTRACTS:		
Contract No. 20, Construction of Coldbrook-Swift Tunnel	$1,937,314.60	$2,240,471.82
Total Contracts	$1,937,314.60	$2,240,471.82
PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:		
Labor	$0.00	$64.75
Installed Equipment	0.00	91.87
Miscellaneous Expense	140.06	233.44
Total	$140.06	$390.06
Total Coldbrook-Swift Tunnel	$2,007,287.74	$2,490,551.19
QUABBIN RESERVOIR, SWIFT SUPPLY		
GENERAL OVERHEAD:		
Administration	$10,763.44	$69,992.93
Engineering	43,020.41	406,745.19
Total General Overhead	$53,783.85	$476,738.12
ENGINEERING:		
Salaries, Engineering and Clerical	$10,782.51	$271,716.09
Labor	1,377.20	4,460.79
Furniture and Fixtures	77.49	2,940.97
Laboratory Equipment	48.24	258.94
Laboratory Supplies	306.14	306.14
Rental of Equipment	16.25	16.75
Engineering Instruments	470.97	6,167.24
Rent and Upkeep	991.97	4,055.64
Automobile Purchase	540.00	12,646.10
Automobile Maintenance	609.42	11,073.20
Special Experiments	0.00	392.40
Contracts for Investigations and Surveys	-997.69 [1]	10,594.79
Office Buildings	0.00	4,835.91
Miscellaneous Expense (undistributed)	478.28	3,736.47
Printing and Blueprinting	264.77	1,218.21
Stationery and Office Supplies	531.87	3,928.11
Postage	127.39	514.39
Total Engineering	$15,624.81	$338,862.14

[1] Expenditure previously carried in this account but chargeable in its entirety to the Main Dam and Dike has been transferred to the proper account.

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
REAL ESTATE:		
Legal and Expert Expense	$10,412.29	$118,431.82
Labor	4.00	71.35
Furniture and Fixtures	0.00	15.68
Miscellaneous Expense (undistributed)	1,026.49	3,899.48
Advertising	0.00	208.66
Printing and Blueprinting	151.04	706.22
Stationery and Office Supplies	0.00	0.45
Purchases and Settlements	399,744.82	5,082,251.98
Taxes	36,872.47	124,903.17
Maintenance of Real Estate	806.19	1,555.53
Water Supply Systems	16.00	16.00
Fire Protection, Equipment	96.89	3,435.86
Automobile Purchase	0.00	771.69
Automobile Maintenance	3.80	222.85
Labor	6.00	6.00
Miscellaneous Expense	16.43	92.42
Police Protection, Labor	0.00	10.00
Special Agents, Salaries	2,460.00	11,001.33
Equipment	0.00	118.33
Automobile Purchase	319.00	1,236.96
Automobile Maintenance	354.89	2,017.06
Miscellaneous Expense (undistributed)	165.25	799.09
Printing and Blueprinting	0.00	41.60
Stationery and Office Supplies	1.53	8.32
Postage	2.90	10.32
Renting Agents, Salaries	2,820.00	12,835.43
Furniture and Fixtures	0.00	29.29
Miscellaneous Expense (undistributed)	86.80	386.02
Stationery and Office Supplies	7.29	16.08
Postage	22.29	22.29
Payments to Towns	0.00	6,000.00
Total Real Estate	$455,396.37	$5,371,121.28
QUABBIN RESERVOIR DAMAGES:		
Salaries, Engineering	$0.00	$48.68
Legal and Expert Expense	931.00	931.00
Consultant Expense	0.00	1,443.37
Miscellaneous Expense	9.55	12.25
Purchases and Settlements	29,720.00	43,860.00
Total Quabbin Reservoir Damages	$30,660.55	$46,295.30
SWIFT DIVERSION DAMAGES:		
Salaries, Engineering and Clerical	$19,070.54	$43,519.61
Legal and Expert Expense	2,156.12	3,308.12
Consultant Expense	20,684.18	27,102.75
Labor	28.80	73.70
Laboratory Equipment	39.39	577.35
Laboratory Supplies	279.52	300.50
Engineering Instruments	0.00	561.03
Rental of Equipment	0.00	9.00
Automobile Maintenance	263.17	306.79
Contracts for Investigations and Surveys	0.00	569.47
Materials of Construction	0.00	18.99
Miscellaneous Expense (undistributed)	716.96	4,984.58
Printing and Blueprinting	268.64	385.90
Purchases and Settlements	0.00	202,500.00
Total Swift Diversion Damages	$43,507.32	$284,217.79

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
QUABBIN RESERVOIR — CEMETERIES*		
QUABBIN PARK CEMETERY CONSTRUCTION:		
Salaries, Engineering and Clerical	$5,379.48	$10,364.44
Legal and Expert Expense	−3.75	65.00
Consultant Expense	125.00	125.00
(Construction) Labor	2,513.77	7,381.53
Tools and Equipment	82.33	82.33
Automobile Purchase	−2,214.63	1,615.37
Automobile Maintenance	326.59	533.42
Rental of Equipment	23.19	33.19
Purchases and Settlements	206.90	4,850.00
Construction Materials	−1,197.42	1,322.63
Purchase and Planting of Trees and Shrubbery	155.60	155.60
Receiving Vault	2,768.85	2,768.85
Water Supply System	1,249.97	1,249.97
Maintenance of Grounds	1,069.70	1,069.70
Transportation of Bodies	−45.00	0.00
Transportation of Monuments	−840.50	0.00
Monuments Including Inscriptions	−252.25	0.00
Miscellaneous Expense (undistributed)	52.83	139.04
Printing, Blueprinting, etc.	150.41	150.41
Stationery and Office Supplies	0.00	3.51
Contract 34, Construction of Driveways	5,472.41	7,842.94
Sub Total Quabbin Park Cemetery Construction	$15,023.48	$39,752.93
REMOVALS FROM CEMETERIES WITHIN RESERVOIR AREA TO QUABBIN PARK CEMETERY:		
Salaries, Engineering and Clerical	$169.55	$169.55
Tools and Equipment	264.26	264.26
Automobile Purchase	2,669.99	2,669.99
Automobile Maintenance	1.45	1.45
Removal and reinterment of bodies	538.69	538.69
Removal and resetting of monuments	164.40	164.40
Miscellaneous Expense	2.00	2.00
Sub Total Removals to Quabbin Park Cemetery	$3,810.34	$3,810.34
REMOVALS FROM CEMETERIES WITHIN RESERVOIR AREA TO CEMETERIES OTHER THAN QUABBIN PARK:		
Salaries, Engineering and Clerical	$4,895.36	$4,895.36
Automobile Purchase	380.00	380.00
Automobile Maintenance	14.80	14.80
Purchases and Settlements	5,659.60	5,659.60
Perpetual Care Fund Contributions	100.00	100.00
Removal and Reinterment of Bodies	5,234.95	5,234.95
Removal and Resetting of Monuments	4,659.19	4,659.19
Miscellaneous Expense	117.91	117.91
Sub Total Removals to Other Cemeteries	$21,061.81	$21,061.81
Total Quabbin Reservoir Cemeteries	$39,895.63	$64,625.08
PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:		
Installed Equipment	$0.00	$214.78
Total	$0.00	$214.78

*New accounts have been opened during the year to show separately and in greater detail the costs of Quabbin Park Cemetery and of removals of bodies, thus necessitating transfers from many of the old accounts to new accounts.

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
HIGHWAY AND PUBLIC UTILITY RELOCATION:		
Salaries, Engineering and Clerical	$42,458.34	$48,470.59
Legal and Expert Expense	9.00	49.10
Labor	153.20	241.70
Contract No. 21, Construction of about 5.2 miles of the Ware-Belchertown Highway	76,799.84	124,980.25
Installed Equipment	97.82	97.82
Temporary Equipment	149.50	149.50
Engineering Instruments	166.77	166.77
Automobile Purchase	535.00	535.00
Automobile Maintenance	1,010.72	1,050.47
Miscellaneous Expense (undistributed)	543.17	576.66
Printing and Blueprinting	2.71	19.39
Stationery and Office Supplies	59.57	59.57
Total	$121,985.64	$176,396.82
Total Quabbin Reservoir, Swift Supply	$760,854.17	$6,758,471.31
QUABBIN RESERVOIR — MAIN DAM AND DIKE		
GENERAL OVERHEAD:		
Administration	$11,425.26	$16,522.61
Engineering	45,664.48	65,415.95
Total General Overhead	$57,089.74	$81,938.56
ENGINEERING:		
Salaries, Engineering and Clerical	$39,287.51	$63,990.38
Consultant Expense	6,258.67	7,571.22
Labor	839.30	1,007.40
Furniture and Fixtures	0.00	64.18
Laboratory Equipment	193.57	759.77
Rental of Equipment	430.50	430.50
Engineering Instruments	145.82	145.82
Rent and Upkeep	16.00	16.00
Automobile Maintenance	513.35	560.63
Contracts for Investigations and Surveys	11,211.95	49,984.46
Miscellaneous Expense (undistributed)	1,080.75	1,900.95
Printing and Blueprinting	376.62	376.62
Stationery and Office Supplies	80.27	145.05
Total Engineering	$60,434.31	$126,952.98
PERMANENT CONSTRUCTION — CONSTRUCTION CONTRACTS:		
Contract No. 30, Constructing Stream Control Works at Main Dam	$364,973.98	$424,335.73
Contract No. 32 Constructing Exploratory Caissons at Main Dam and Dike	151,590.58	162,838.33
Total Contracts	$516,564.56	$587,174.06
PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:		
Labor	$2,519.40	$2,519.40
Installed Equipment	3,253.00	3,253.00
Temporary Equipment	1,549.81	1,549.81
Miscellaneous Expense	1,093.01	1,096.01
Total	$8,415.22	$8,418.22
Total Quabbin Reservoir — Main Dam and Dike	$642,503.83	$804,483.82

Southern Sudbury Emergency Supply

	Year ending Nov. 30, 1932	Total to Nov. 30, 1932
General Overhead	$0.00	$42,098.25
Engineering	0.00	44,235.07
Real Estate:		
Legal and Expert Expense	7.78	2,221.60
Consultant Expense	0.00	116.87
Printing and Blueprinting	0.00	4.28
Purchases and Settlements	0.00	27,763.22
Taxes	138.81	392.60
Total Real Estate	$146.59	$30,498.57
Southern Sudbury Diversion Damages	0.00	50,752.66
Permanent Construction – Construction Contracts (except No. 5)	0.00	375,194.44
Contract No. 5, Cordaville Pipe Line	0.00	83,262.86
Permanent Construction — Except Construction Contracts	0.00	11,937.37
Total Southern Sudbury Emergency Supply	$146.59	$637,979.22

Summary

Wachusett-Coldbrook Tunnel, Ware Supply	$209,118.35	$11,427,819.80
Special Investigation — Pollution of Ware and Quinapoxet Watersheds	0.00	1,995.99
Coldbrook-Swift Tunnel	2,007,287.74	2,490,551.19
Quabbin Reservoir, Swift Supply	760,854.17	6,758,471.31
Main Dam and Dike	642,503.83	804,483.82
Southern Sudbury Emergency Supply	146.59	637,979.22
Unassigned	–38.79	604.72
Grand Total	$3,619,871.89	$22,121,906.05

Receipts from Rents, Sales, etc.

Receipts from Sales	$18,060.16	$108,324.49
Receipts from Rents	51,293.42	204,407.20
Miscellaneous Receipts	567.85	2,919.99
Total Receipts	$69,921.43	$315,651.68

COMMONWEALTH OF MASSACHUSETTS

METR. DISTR. WATER SUPPLY COMMISSION

LOCATION OF REAL ESTATE ACQUIRED FOR THE QUABBIN RESERVOIR

(TITLE VESTED IN COMMONWEALTH)

TOWNS	TOTAL – NOV. 30, 1931.		TOTAL FOR YEAR ENDING NOV. 30, 1932 (ACRES)	TOTAL NOV. 30, 1932 (ACRES)	REMARKS
	1931 ANNUAL REPORT (ACRES)	REVISED - SEE NOTE (ACRES)*			
BELCHERTOWN	1,653	1,575	88	1,663	* Revisions have been made using acreages obtained from surveys wherever available otherwise from deeds, property blanks etc.
DANA	6,871	6,808	679	7,487	
ENFIELD	6,410	6,542	515	7,057	
GREENWICH	8,401	8,791	744	9,535	
HARDWICK	2,224	2,130	103	2,233	
NEW SALEM	5,425	5,539	779	6,318	
PELHAM	2,095	2,102	589	2,691	
PETERSHAM	961	761	–	761	
PRESCOTT	8,619	8,798	185	8,983	
SHUTESBURY	1,490	1,473	45	1,518	
WARE	426	425	35	460	
WENDELL	37	36	–	36	
TOTALS	44,612	44,980	3,762	48,742	

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COMMONWEALTH OF MASSACHUSETTS

METR. DISTR. WATER SUPPLY COMMISSION

TAKINGS OF REAL ESTATE (AND WATER RIGHTS)

TAKING FOR	TAKING NO.	TOWN	COUNTY	DATE OF TAKING	PLAN NO.	TITLE VESTED IN COMMONWEALTH	
						FEE (Acres)	EASEMENT (Acres)
Southern Sudbury Emergency Supply.	1 to 9 inc.	Details previously reported in 1930			C-1 to C-15 incl.	258.81 (Also Water Rights)	29.02
Wachusett-Coldbrook Tunnel.	1 to 4 inc.	Details previously reported in 1930			T-1 to T-13 incl.	570.22	
Coldbrook-Swift Tunnel.	1 to 3 inc.	Details previously reported in 1931 *(391.42 acres of this total are within the Swift River Res. Area)			T-14 to T-27 incl.	*544.81	4.06
Swift River Reservoir	1 to 3 inc.	Details previously reported in 1931			S-1 to S-7 incl.	205.84	0.39
" " "	4	Ware	Hampshire	Aug. 16, 1932	S-8	47.76	
" " "	5	Enfield	Hampshire	Nov. 1, 1932	S-9	174.40	
		Greenwich	Hampshire			2.00	
		Ware	Hampshire			1.90	
						431.90	
Ware River Watershed,-School.	1	Oakham	Worcester		W-1	0.25	
" " Taking of Flood Waters of the Ware River and its Tributaries above Diversion Dam at Coldbrook in Barre.		Barre	Worcester		No Plan	Water Rights	

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION

STATUS OF CONTRACTS COMPLETED BETWEEN NOV. 30, 1930 AND NOV. 30, 1932

CONT. NO.	DESCRIPTION	LOCATION	SUPPLY	CONTRACTOR	BIDS OPENED	NO. OF BIDS	CONTRACT AWARDED	BASIS OF AWARD	FINAL ESTIMATE	DATE OF FINAL EST.
10.	Transmission Line for Construction of Wachusett-Coldbrook Tunnel.	Tunnel Line	Ware	New England Power Company	Date of Agreement-April 27, 1927			Maint. at Cost. Constr. at Cost.	#33,107.81 86,439.58	June 10, 1931
14.	East Portion of Wachusett-Coldbrook Tunnel.	West Boylston, Holden and Rutland.	Ware	West Construction Co. Assignee	Nov. 18, 1927	13	April 30, 1928	4,074,981.25*	3,515,787.08	July 28, 1931
17.	West Portion of Wachusett-Coldbrook Tunnel.	Rutland, Oakham and Barre.	Ware	West Construction Co. Assignee	Nov. 18, 1927	12	April 30, 1928	4,799,362.50**	4,127,094.19	May 15, 1931
19.	Dam and Substructure of Intake Building.	Barre.	Ware	J. W. Bishop Co.	July 16, 1929	7	July 23, 1929	273,077.00	285,580.49	Mar. 9, 1931
21.	Portion of the Ware Belchertown Highway	Ware and Belchertown.	Swift	The Lane Construction Corporation	July 17, 1931	17	July 17, 1931	208,381.50	+225,707.19	Oct. 11, 1932
22.	Unwatering Pump at Shaft 1.	West Boylston.	Ware	F. A. Mazzur Co., Inc.	Nov. 5, 1929	3	Nov. 12, 1929	11,975.00	13,371.76	Feb. 13, 1932
24.	Superstructure of Ware River Intake Building.	Barre.	Ware	Munroe & Wescott Inc.	July 22, 1930	10	July 22, 1930	69,669.00	70,114.04	Jan. 6, 1932
25.	Superstructure of Outlet Works at Shaft 1.	West Boylston	Ware	Munroe & Wescott Inc.	July 22, 1930	10	July 22, 1930	61,363.00	62,329.23	Jan. 6, 1932
26.	Wiring and Electrical Equipment Outlet Works Shaft 1.	West Boylston	Ware	Anderson-Coffey Co. Inc.	Sept. 23, 1930	8	Sept. 23, 1930	8,850.00	10,685.21	Feb. 3, 1932
27.	Earth Fill along Ware River.	Barre	Ware	Raymond A. Bergesson	Sept. 23, 1930	14	Sept. 23, 1930	4,050.00	4,395.51	Dec. 20, 1930
28.	Grading Grounds of Ware River Intake Building.	Barre	Ware	Anthony Ross & Son	Aug. 14, 1931	16	Aug. 14, 1931	6,571.75	8,164.14	Aug. 6, 1932
29.	Grading Grounds of Wachusett Outlet Building.	West Boylston	Ware	Anthony Ross & Son	Aug. 14, 1931	17	Aug. 14, 1931	9,998.05	11,852.68	Aug. 6, 1932
31.	Head House at Shaft 4.	Rutland	Ware	E. D. Ward Co.	Aug. 25, 1931	8	Aug. 25, 1931	5,439.00	5,689.02	Jan. 6, 1932
32.	Exploratory Caissons at Main Dam and Dike of Quabbin Reservoir.	Enfield and Ware	Swift	Dravo Contracting Co.	Sept. 8, 1931	10	Sept. 8, 1931	(A) 115,900.00 (B) 133,825.00	162,838.33	Sept. 20, 1932
34.	Driveways in Quabbin Park Cemetery.	Ware	Swift	The Lane Construction Corporation.	Oct. 20, 1931	16	Oct. 27, 1931	4,967.50	7,842.94	Aug. 8, 1932

Awarded to lowest bidder in each case.

Note:- For contracts completed prior to Nov. 30, 1930 - See the 1931 Annual Report.

(A) = Assuming caissons to be sunk mostly by open dredging.
(B) = " " " " " " under pressure.

\+ Of this amount the State Dept. of Public Works paid #95,726.94.

* Portion of work completed under Contract 12 before Contract 14 was executed reduces this amount by about 7%.

** " " " " " Contracts 4 & 8 " " 17 " " " " " " " " .

COMMONWEALTH OF MASSACHUSETTS

METR. DISTR. WATER SUPPLY COMMISSION

STATUS OF CONTRACTS IN FORCE ON NOV. 30, 1932

CONT. NO.	DESCRIPTION	LOCATION	SUPPLY	CONTRACTOR	BIDS OPENED	NO. OF BIDS	DATE AWARDED	BASIS OF AWARD	PAYMENTS TO DATE
20.	Coldbrook-Swift Tunnel.	Barre, Hardwick and Greenwich.	Swift	Wenzel & Henoch, Construction Co.	Mar. 27, 1931	13	April 10, 1931	$ 4,978,031.80	$ 2,240,471.82
23.	Making Borings.	Belchertown, Ware, Enfield, Greenwich & Hardwick.	Swift	Sprague & Henwood Inc.	Nov. 5, 1929	6	Nov. 5, 1929	10,950.00	27,695.92
30.	Stream Control Works at Main Dam Quabbin Reservoir.	Belchertown, Enfield and Ware.	Swift	Northern States Contracting Co.	July 17, 1931	19	July 21, 1931	560,922.50	424,335.73
33.	Purchase of Power at Shaft 1.	West Boylston	Ware	New England Power Co.	Date of Agreement = Aug. 6, 1931			Agreed Rates	1,425.03
35.	Purchase of Power at Dam Site.	Enfield	Swift	New England Power Co.	Date of Agreement - June 2, 1932			Agreed Rates	453.50
37.	Purchase of Power at Dike Site.	Enfield	Swift	New England Power Co.	Date of Agreement - Sept. 21, 1932			Agreed Rates	None

Awarded to lowest bidder in each case.